Thesis Presentation

on

Creation of AES-Enabled Secure JAB Code for Color Barcode Applications and its Integration with Medicinal Plants Information

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Content

- Introduction
- Review of literature
- Materials and methods
- Results and Discussion
- Summary and Conclusions
- References

INTRODUCTION

What is barcode?

- Barcode: A visual representation of data.
- Consists of parallel lines and spaces.
- Structured to contain a specific piece of information.
- Scanned by barcode readers or smartphones.
- Used for tracking, inventory management, and pricing.
- Found on product packaging, shipping labels, tickets, and more.
- Speeds up transactions and reduces human error.
- Easy to create, print, and scan.
- Widely adopted in retail, logistics, and other industries.

Types of Barcode:

- One is 1D (1-Dimensional) and other is 2D (2-Dimensional).
- "1D" Barcode is used in normal products like groceries, pen, and electronic equipment's etc. and it use light wave process.
- "2D" is similar to 1-Dimensional Barcode, but it can store more data per unit area as compared to the 1D

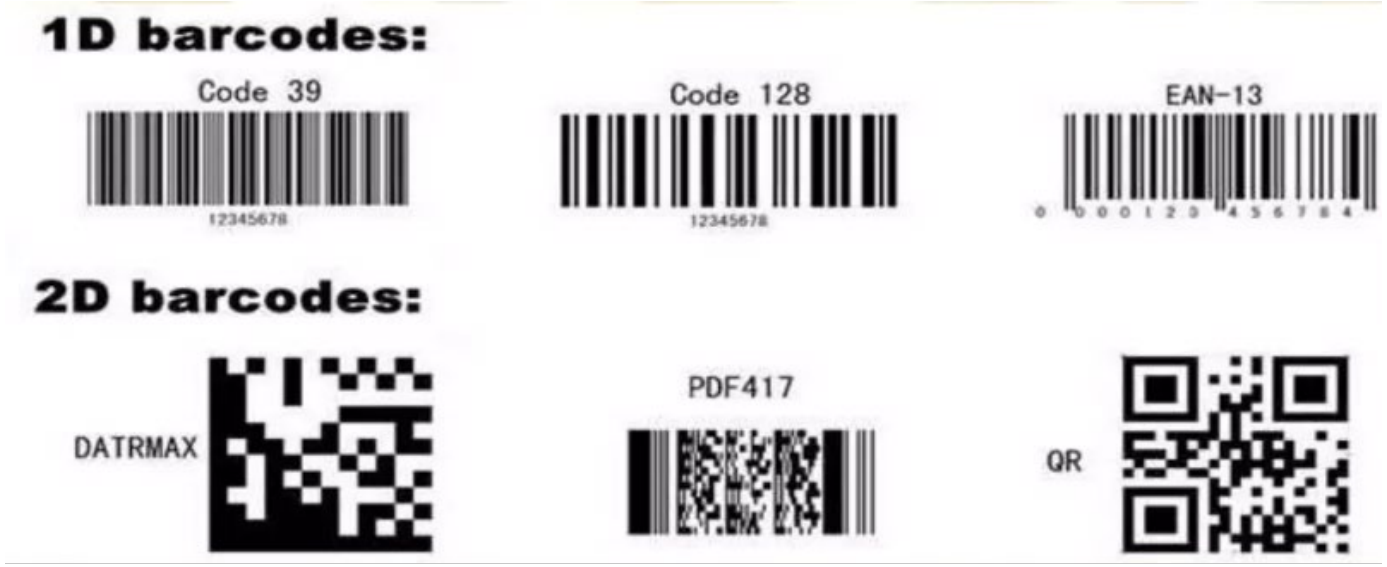


Fig. 1: Multiple types of Barcode

Different Types of 2D Barcodes

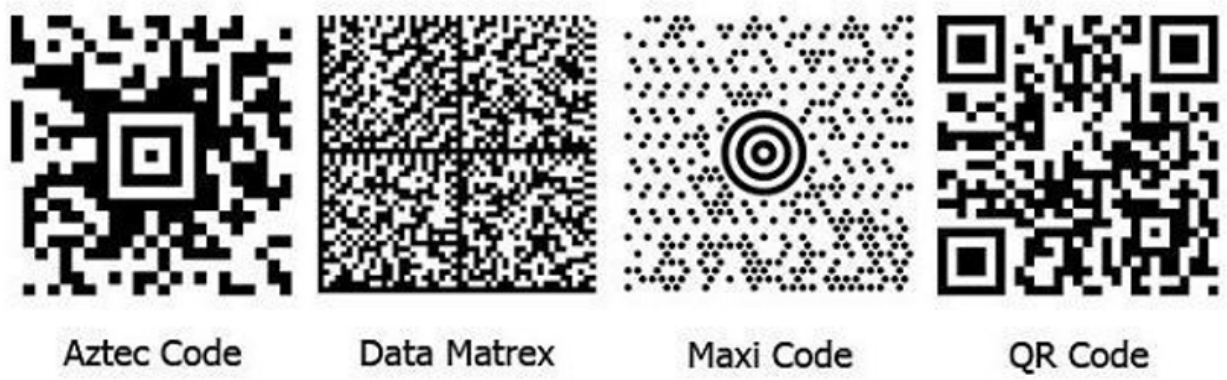


Fig. 2: Different Type of 2D barcodes

Comparison of various Barcodes

Name of Code		QR Code	PDF417	Data Matrix	Maxi Code
Developed by		DENSO(Japan)	Symbol Technologies (USA)	RVSI Acuity CiMatrix (USA)	UPS (USA)
Types:		Matrix	Stacked Bar Code	Matrix	Matrix
Data capacities	Numeric	7,089	2,710	3,116	138
	Alphanumeric	4,296	1,850	2,355	93
	Binary	2,953	1,018	1,556	
	Kanji/kana	1,817	554	778	
Main features:		Large capacity, small printout size and High speed scan	Large capacity	Small printout size	High speed scan

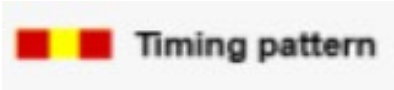
Fig. 3: Comparison b/w various 2D Barcodes

Structure of QR Code

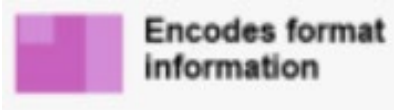
Finder pattern

Alignment pattern

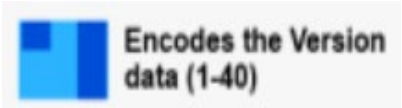
Timing pattern



Format information



Version Information



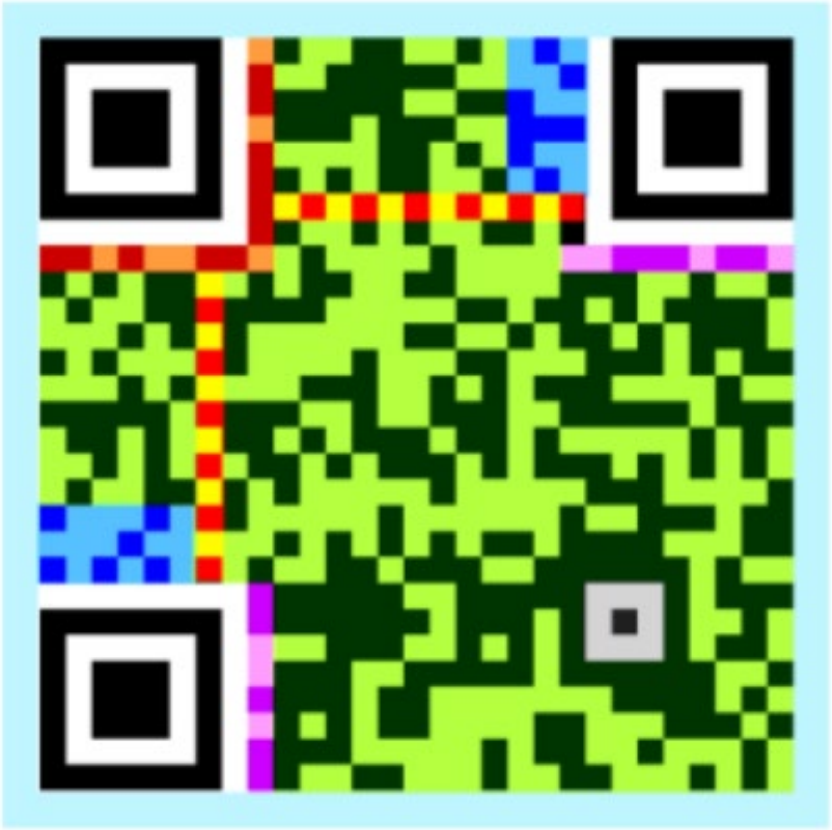


Fig. 4: QR Code Structure

Logo QR Code (modified QR code)

- LogoQ is a new type of QR Code is designed to increase visual recognition by combining it with letters and pictures in full color

Fig. 5: Logo QR Code

- These are divided into two types: foreground and background modules
- Foreground modules are typically black squares, and background modules are typically white squares.
- It is important that scanner can clearly distinguish between foreground and background modules in order to detect the valid pattern of the QR code.

Examples of the artistic uses of QR Codes

Fig. 6: Example of Logo QR Code

What is Multi-Colored Barcode?

- JAB Code: "Just Another Barcode"
- 2D color barcode system
- Uses colored dots in a matrix pattern
- Encodes more data than traditional barcodes
- Resistant to printing and scanning errors
- Can encode alphanumeric and binary data
- Combines multiple colors for increased capacity
- Applications: Product labeling, Securing physical documents with digital signatures

Structure of JAB Code Master Symbol

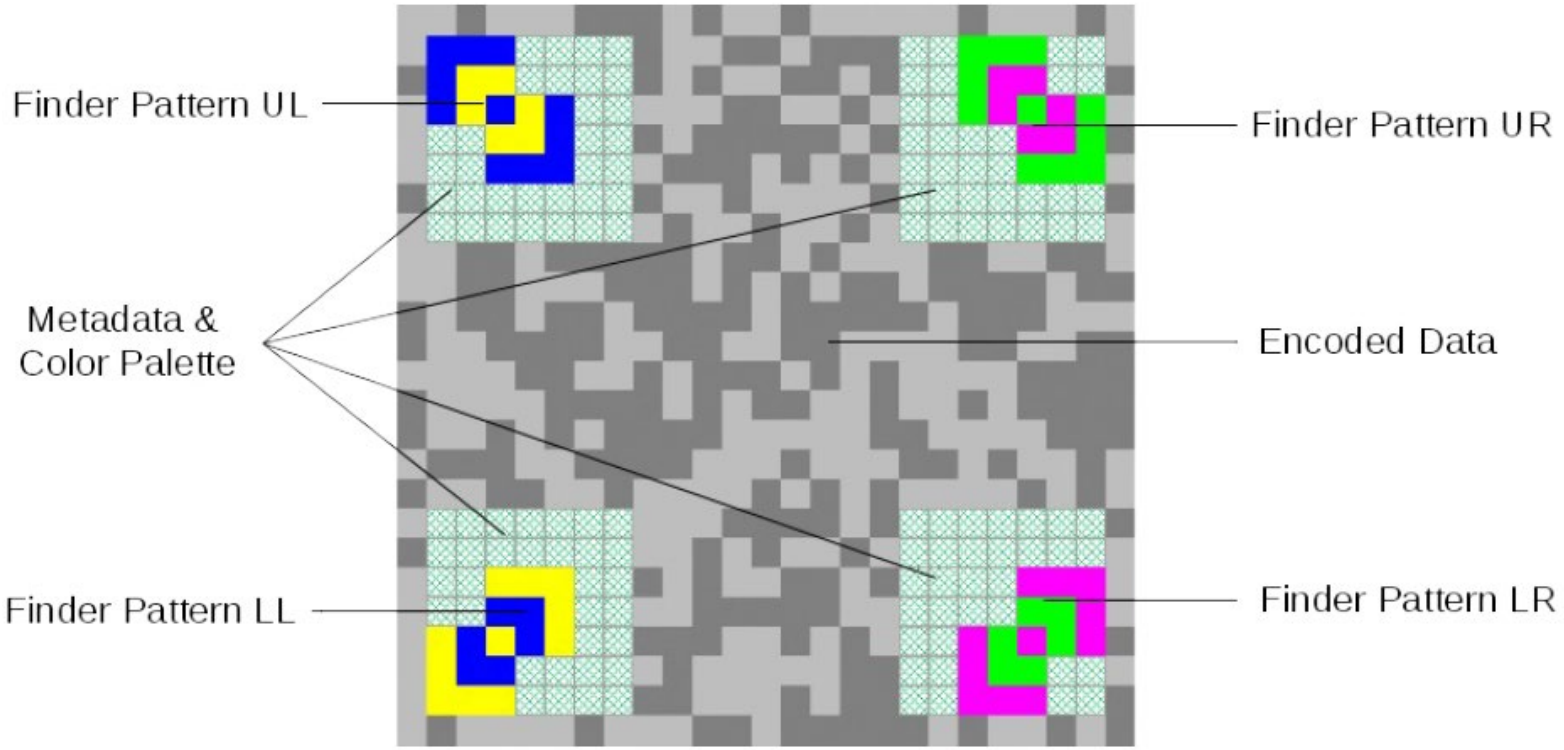


Fig. 7: Structure of a Primary Symbol (Master Symbol)

Structure of JAB Code Slave symbol

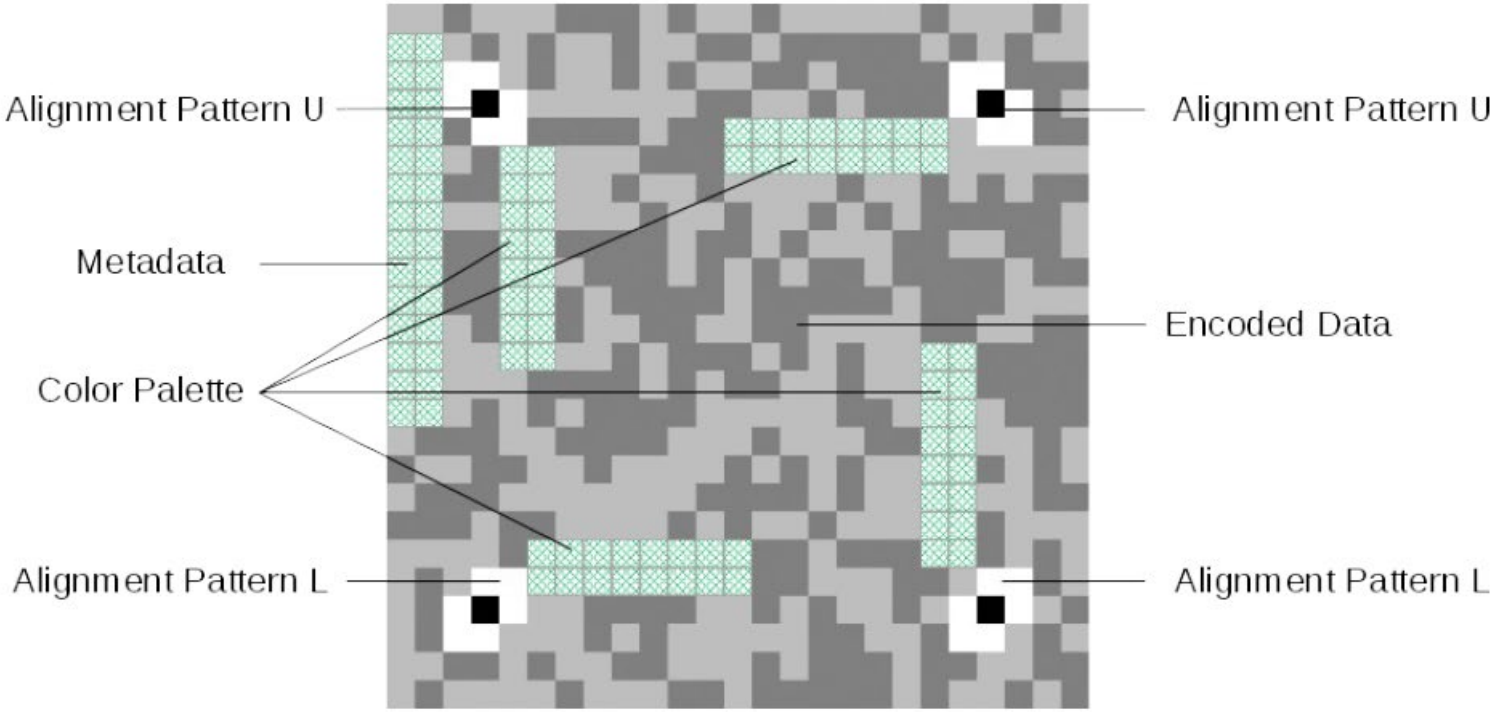


Fig. 8: Structure of a Secondary Symbol (Slave Symbol)

Master and Slave Architecture

					41					
				42	25	43				
			44	26	13	27	45			
		46	28	14	5	15	29	47		
	48	30	16	6	1	7	17	31	49	
59	39	23	11	3	**0**	4	12	24	40	60
	57	37	21	9	2	10	22	38	58	
		55	35	19	8	20	36	56		
			53	33	18	34	54			
				51	32	52				
					50					

Fig. 9: Order of Master and Slave symbols

Master symbol capacity with different Colour palette

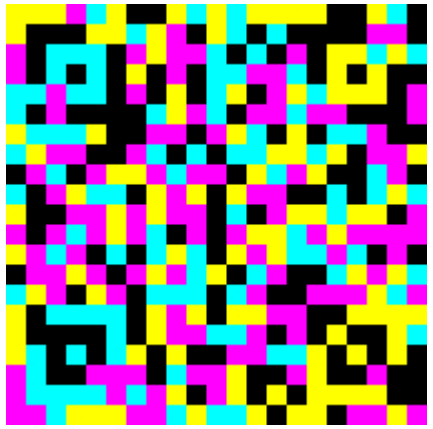


Fig. 10: 4-color

1 primary and **0** secondary symbols
Primary symbol width: **1160 px (145 modules)**
Primary symbol height: **1160 px (145 modules)**
Approximate capacity in bits: **22418**
or **3736** alphanumeric characters

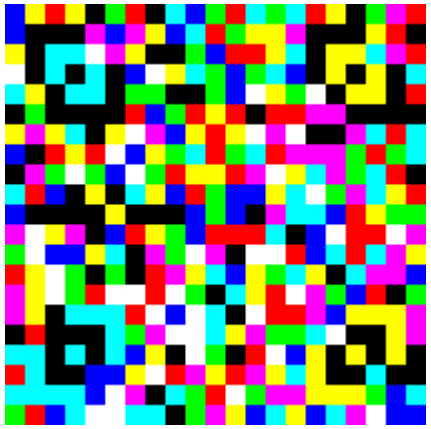


Fig. 11: 8-color

1 primary and **0** secondary symbols
Primary symbol width: **1160 px (145 modules)**
Primary symbol height: **1160 px (145 modules)**
Approximate capacity in bits: **33647 (4.2KB)**
or **5607** alphanumeric characters

Color	Black	Blue	Green	Cyan	Red	Magenta	Yellow	White

Problem Statement

- Absence of offline applications capable of creating and managing Just Another Bar Code (JAB Code).
- Standard barcodes can be easily read by anyone, and the information within them is not encrypted, leading to a high risk of data leakage.
- The lack of a robust verification mechanism for product authenticity allows for the spread of counterfeit products, causing harm to both consumers and legitimate manufacturers.
- The need for a secure method of text transmission is amplified due to the increasing instances of cyber-attacks and data breaches (question paper, personal details, patient identification, mark sheet details etc).

Objective

- To create application which capable of creating JAB Codes offline as there is no offline application available for creating JAB Codes which forcing users to rely on potentially insecure online platforms.
- To add security in JAB Code so only authorized person can read it. As the existing standard barcodes can be read by anyone which resulting in a lack of data privacy and security.
- New verification method using application to counter issues of counterfeit products.
- Secured text transmission methods that can be easily accessed which mitigate the risk of unauthorized access to sensitive information.

LITERATURE REVIEW

Literature Review

Serial Number	Author	Year	Explanation
1	Waldemar Berchtold	2020	Proposed the JAB Code, a new variety of 2D barcode using color and shape information for data encoding. Showcased its robustness, adaptability and resistance to errors.
2	Christian Winter	2019	Introduced a method for enhancing the security of physical documents using cryptographic digital signatures and JAB Code, a high-capacity matrix code. The solution offers offline verification and long-term verifiability.
3	Partiksha Mittra	2016	Described a novel desktop application that enhances data security and authentication using QR codes with a modified Advanced Encryption Standard (AES) algorithm. Showcased its superior security and potential applications.

Literature Review..

Serial Number	Author(s)	Year	Explanation
4	Somdip Dey	2013	Proposed a system that encodes marks obtained by a candidate in an encrypted form inside a QR Code using the asymmetric encryption algorithm to ensure the security and authenticity of data.
5	Vasileios Yfantis	2012	Demonstrated how QR codes are revolutionizing digital education by offering instant access to digital content, enhancing learner engagement, and facilitating real-time assessments.
6	Antonio Grillo	2011	Introduced Color QR Code (CQR), a color barcode that uses color information to encode data. Showcased CQR's storage capacity, mobile-readability, and noise-resistance.

Literature Review..

Serial Number	Author(s)	Year	Explanation
7	Fei Shao	2010	Proposed to enhance the AES algorithm using the high-performance computing capability of GPUs to improve the efficiency of the AES algorithm and reduce long encrypting times.
8	Orhan Bulan	2009	Explored the potential of high-capacity color barcodes by using dot orientation and color separability techniques. Addressed the challenges encountered in the development of color barcodes.
9	Devi Parikh	2008	localizing and segmenting a new type of 2D barcode that makes use of color information to store more data than standard black-and-white barcodes. The proposed barcode, High-Capacity Color Barcode (HCCB), encodes data using a combination of black and white modules and colored triangles compared to traditional 2D barcodes.

Research gap

- The lack of an offline application capable of creating JAB Codes.
- The existing QR code application is limited in data density. Traditional QR codes can only accommodate a finite amount of information in their square format.
- Without an encryption and decryption function, there's a potential risk to data privacy during transmission in the existing QR code application.
- There is a lack of configuration flexibility in QR code applications. Users are constrained to the standard square format and don't have options to change the layout such as to a 'U Shape', 'Vertical', or 'Horizontal' layout.

MATERIALS AND METHODS

Hardware and Software Used

- **Processor:** Intel(R) Core (TM) i3-8130U CPU @ 2.20GHz 2.21 GHz
- **RAM (Installed Memory):** 20.0 GB (19.9 GB usable)
- **System Type:** 64-bit operating system, x64-based processor
- **Storage** - 1TB SSD, 1TB HDD
- **Window 11**
- **VMware Workstation**
- **Ubuntu-14.04 LTS**
- **Ubuntu-22.04 LTS**

Materials

- Materials
  - Development Environment – Linux or Window
  - JAB code Source code
  - Supporting Libraries
    - Libtiff
    - PNG
    - Etc
  - Python (For making application)
  - Python libraries
    - Tkinter
    - Subprocess
    - Etc

Dataset Acquisition and its description

Dataset is collected from university. Table 1 contains description of dataset and its parameter.

S. No	Common Name	Botanical Name & Family	Parts used	Uses
1.	Atibala	Abutilon indicum Malvaceae	Leaves, root, seed	Nervine tonic, aphrodisiac, galactogogue, piles, diuretic
2.	Acalypha	Acalypha indica Euphorbiaceae	Whole plant	Skin disease, snakebite, toothache
3.	Achilia	Achillea millefolium Asteraceae	Leaves, flowers	Dysentry, fever, wound healing
4.	Apamarga	Achyranthus aspera Amaranthaceae	Root, plant	Stone, toothache, asthma , anemia, general debility
5.	Aloe	Aloe barbadensis Lilliaceae	Leaves juice, Roots	Skin disease , Jaundice, Joint pain Menstrual Problem ,

Table 1 Dataset description for generation of barcode for Medicinal Plant.

Images Acquisition of plants

- The medicinal plant images which is combined on JAB code is manually captured from the university, images example are in Fig. 12.

Fig. 12: Medicinal plant images.

Creation of JAB Code

- jabcodeWriter --input 'Hello world' --output test.png

- jabcodeWriter --input 'Hello world' --output test.png --symbol-number 3 --symbol-position 0 3 2 --symbol-version 3 2 4 2 3 2

Fig. 13: test.png Output

Example for 1-symbol-code:

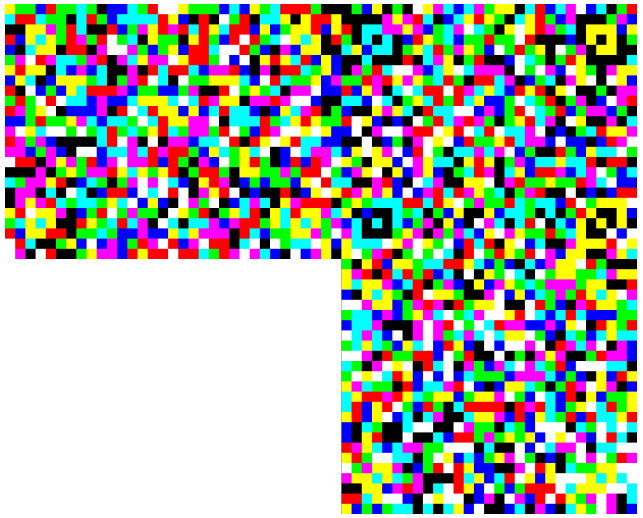


Fig. 14: test.png Output

Example for 3-symbol-code:

Experimental setup of JAB Code for plant information

Fig. 15: U shape JAB Code

Architecture of U shape JAB Code

Slave Position 6		Slave Position 7
Slave Position 3	Master Position 0	Slave Position 4

Fig. 16: U shape JAB Code's Positions of master and slave symbol

Background Removing Process in Plant Images

- To remove the background form images of medicinal plants online tool https://www.remove.bg/ used. Fig. 17 shows background removed images example

Fig. 17: Medicinal Plant Images Background Removed

Integration of plant images in generated JAB Code

- To Integration of the medicinal plant images in generated JAB Code, online image editor tool is used https://www.online-image-editor.com/ by using overlay image function new image of plant is integrated. Fig. 18 shows Integration of the medicinal plant image example.

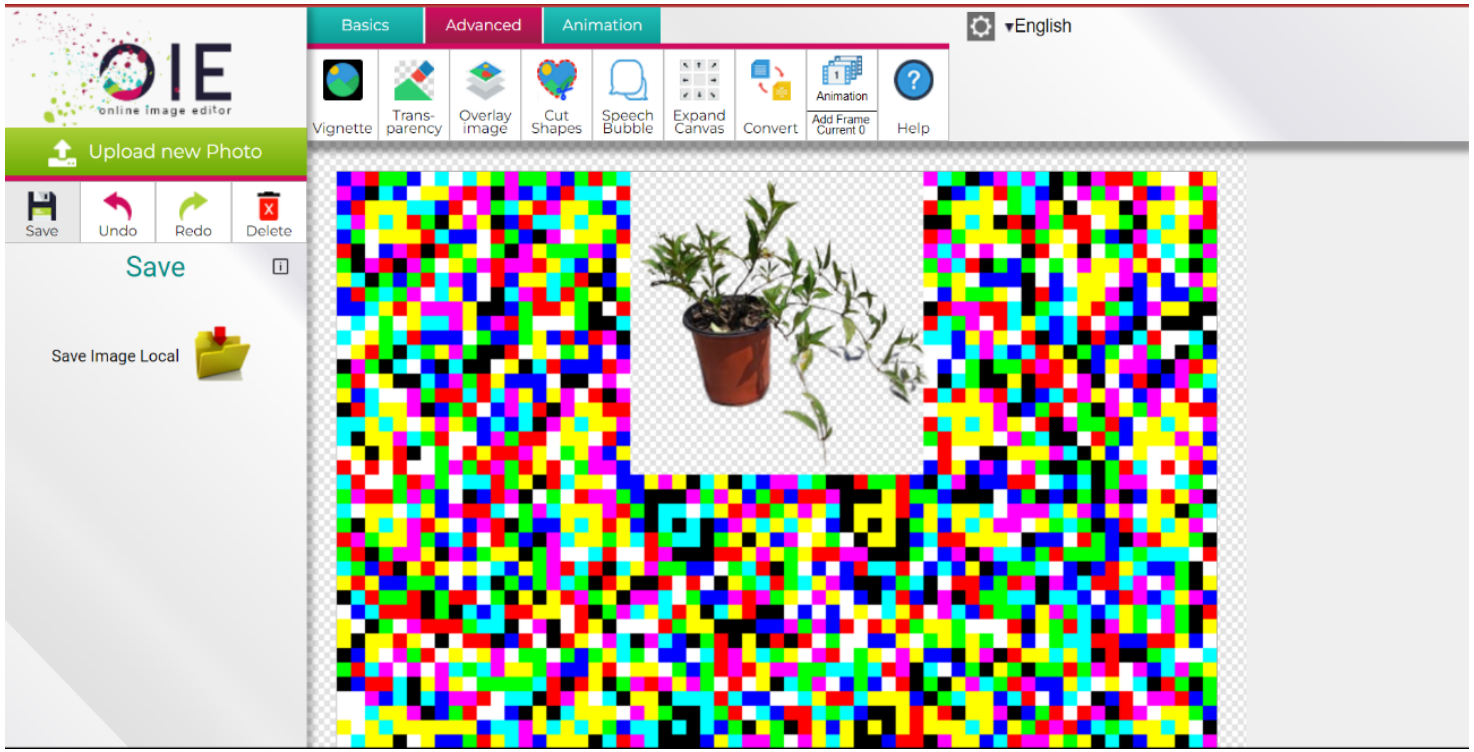
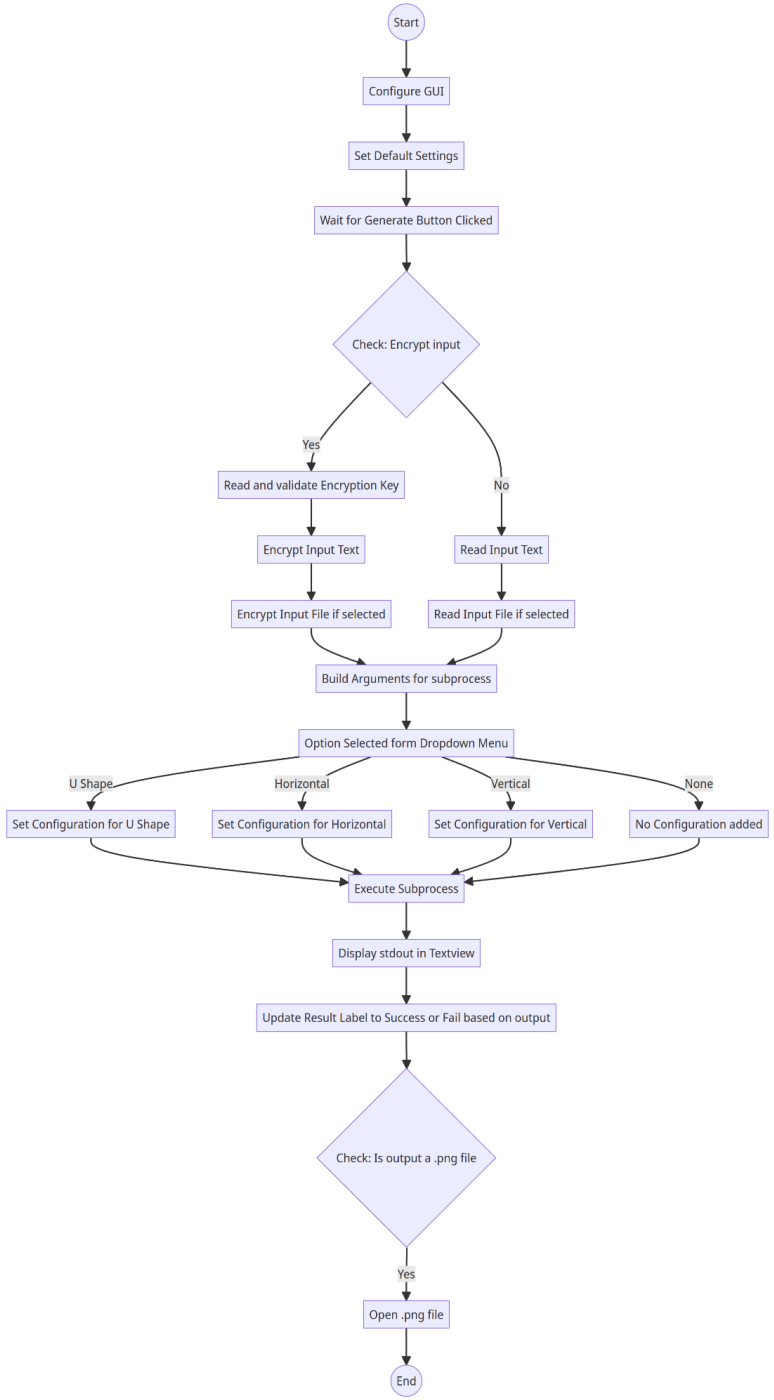


Fig. 18: Integration of the medicinal plant image in U shape barcode

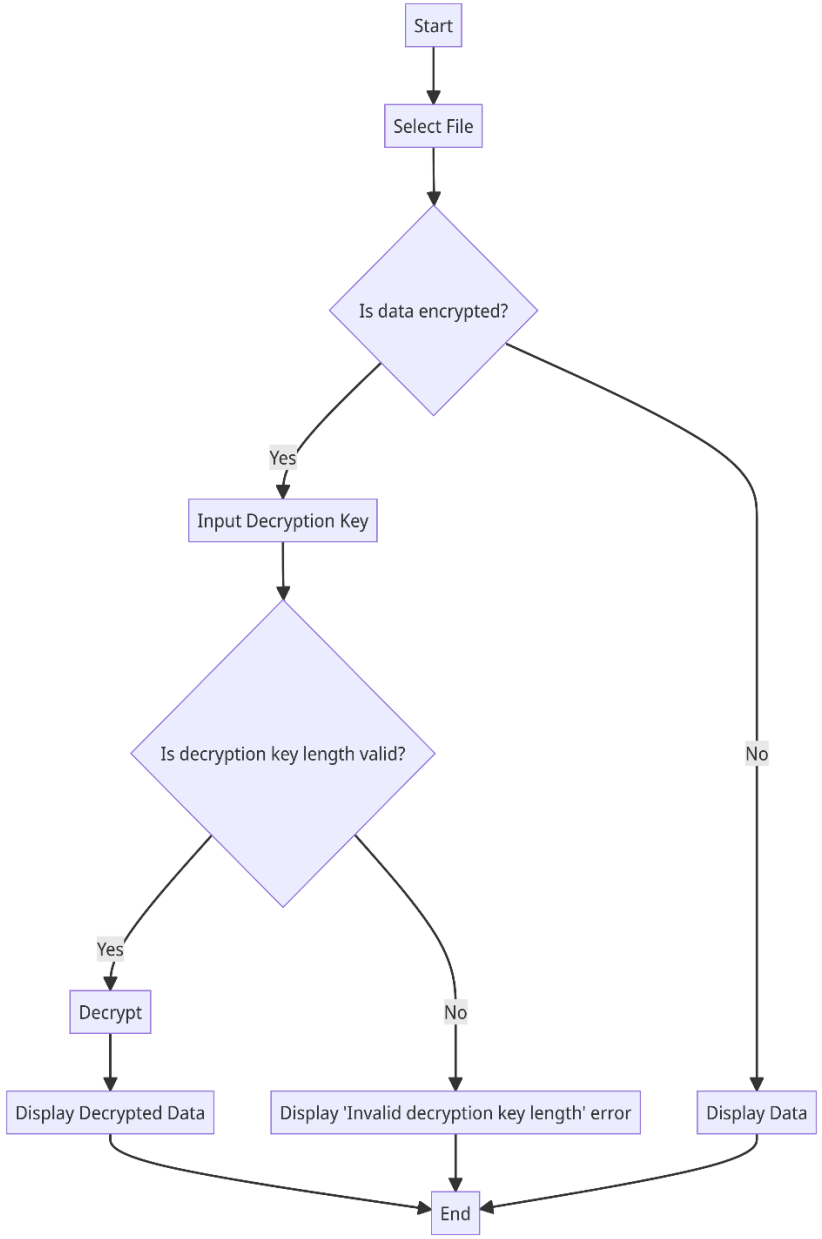
Methodology used for Developing the Application.

1. Implementation:
    1. Implement the application using Python and the tkinter library for GUI development.
    2. Write the necessary functions and methods to handle user interactions and perform the required actions, such as file selection, encryption, and code generation.
    3. Utilize the Crypto.Cipher and Crypto.Util.Padding modules for AES encryption and decryption.
    4. Incorporate subprocess to run external commands and capture their output.
    5. Handle errors and exceptions to provide appropriate feedback to the user.
2. Testing:
    1. Perform unit testing to ensure the correctness of individual functions and components.
    2. Test the application as a whole to ensure that it meets the desired functionality and requirements.
    3. Verify the encryption and decryption processes to ensure data integrity and security.
    4. Conduct user testing to gather feedback and identify any usability issues or bugs.

Flow chart of SecuJAB Generator Application



Flow chart of SecuJAB Reader Application



RESULTS AND DISCUSSION

SecuJAB Generator Application

1) **Shape type** – Normal, U Shape, Horizontal, vertical
2) **Select File** – Enable the File selection option.
3) **File name** – User can enter costume file name.
4) **Encrypt input** – Enable the encryption of the data in barcode.
5) **Encryption Key** – User need to put secret key which can decrypt the data, key should be 16,24,32 character long

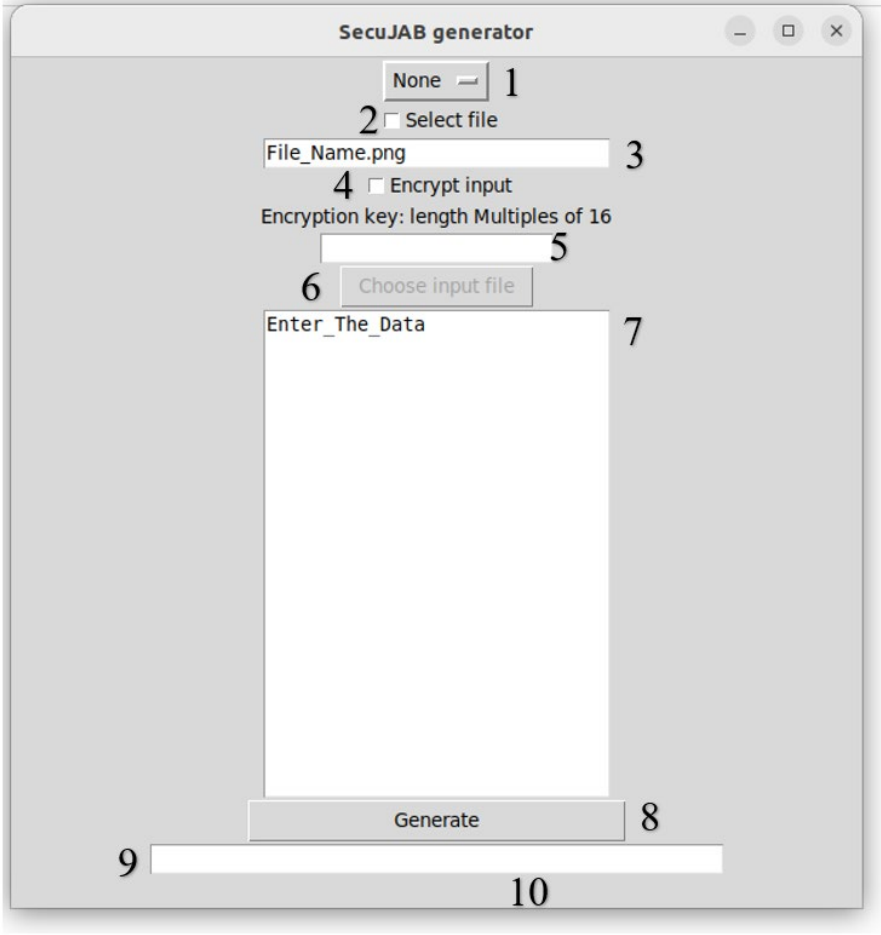


Fig. 19: SecuJAB Generator Application

SecuJAB Generator Application

6) **Choose input file** – User can select the file form this option and selected file's data going to encoded into barcode.
7) **Text Area** – User can type the data in the area which can converted into a barcode.
8) **Generate** – It will generate the barcode.
9) **Error message** – If any kind of error occur it will show the error message.
10) **Result** – It will show the Result of the operation.

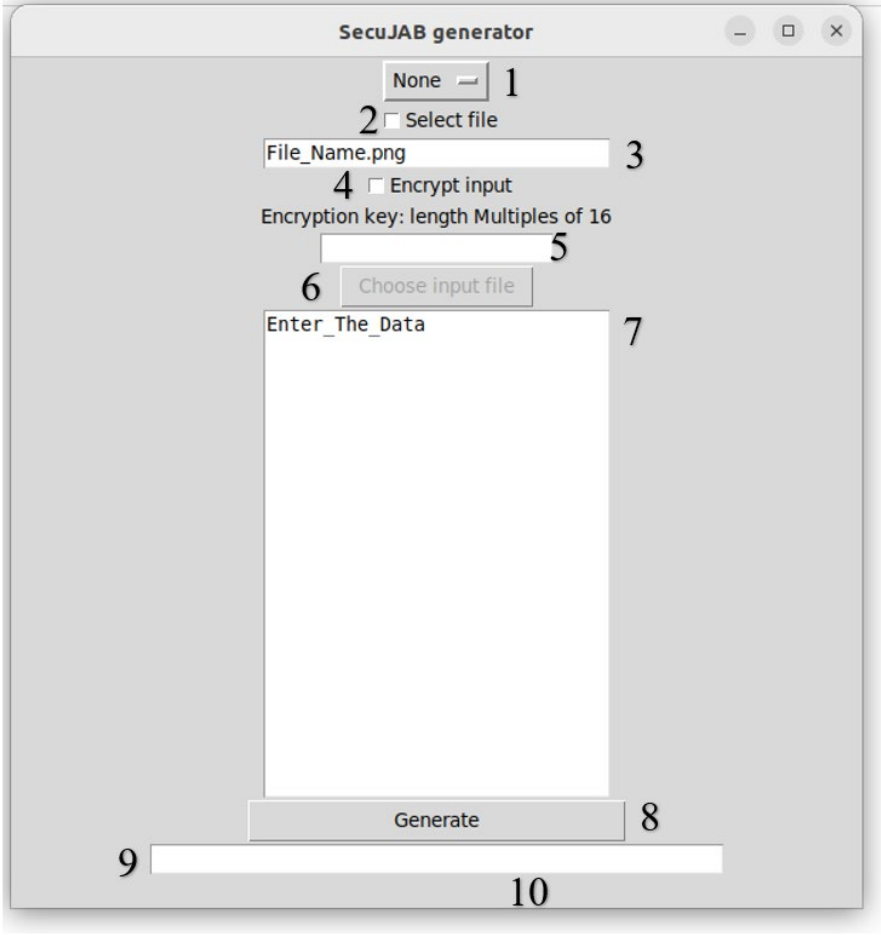


Fig. 19: SecuJAB Generator Application

Generated barcode form Application

Fig. 20: Generating barcode using SecuJAB Generator Application

- When the application is open user can click on Generate Button and It will create a JAB Code barcode, in this case this barcode contains “Enter_The_Data”.

SecuJAB Reader Application.

- User can click on “Select File” to choose the barcode which can be read using this application.
- If barcode is encrypted used need to input the key to read the barcode contains.

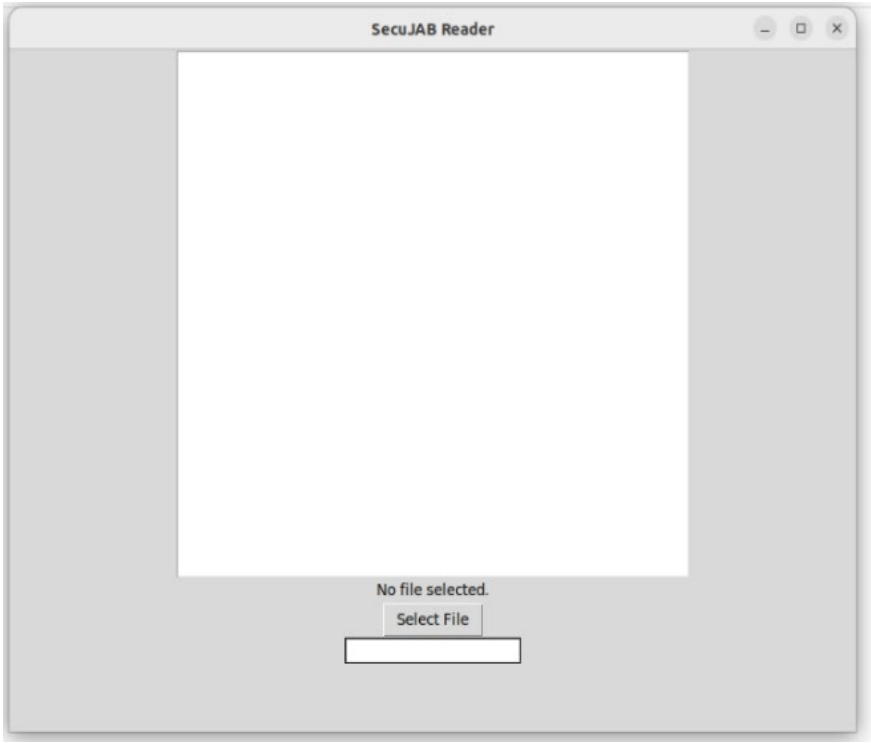


Fig. 21: SecuJAB Reader Application

Barcode with plant image

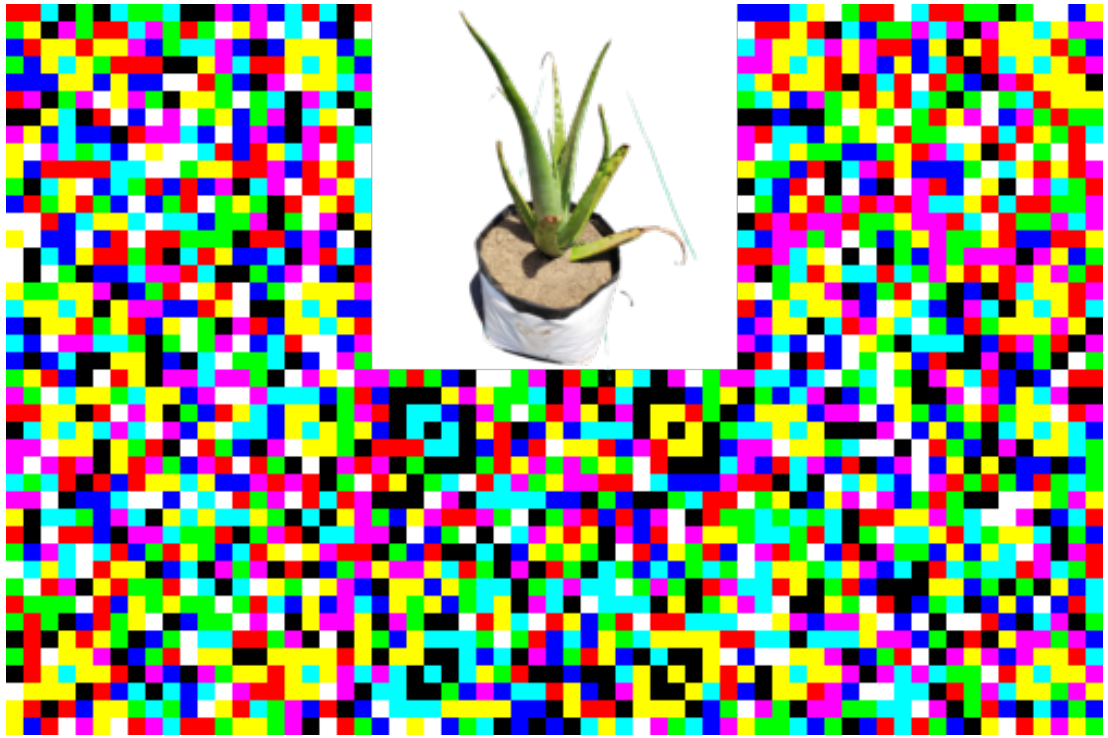


Fig. 22: U shape barcode with plant image containing plant details

Output of barcode

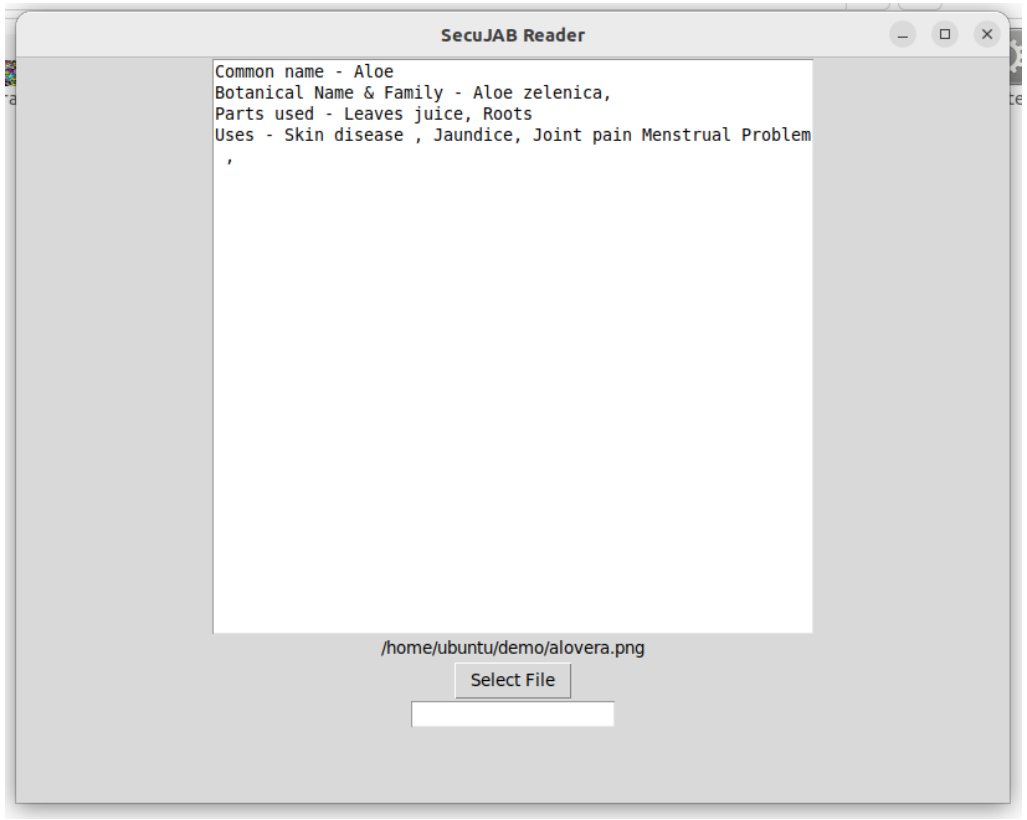


Fig. 23: Reading barcode with SecuJAB reader application

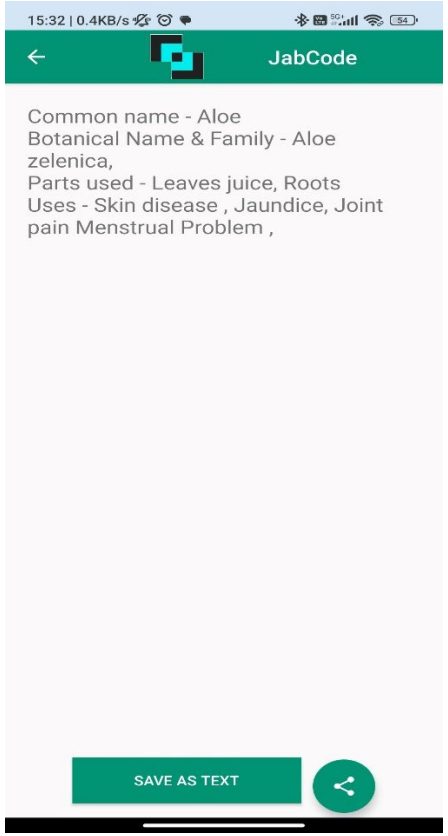


Fig. 24: Scanned barcode form mobile application

Examples..

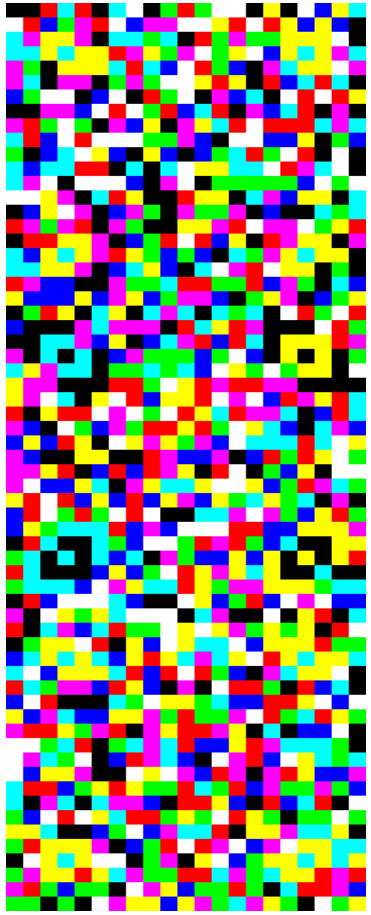
Fig25: Maulsari

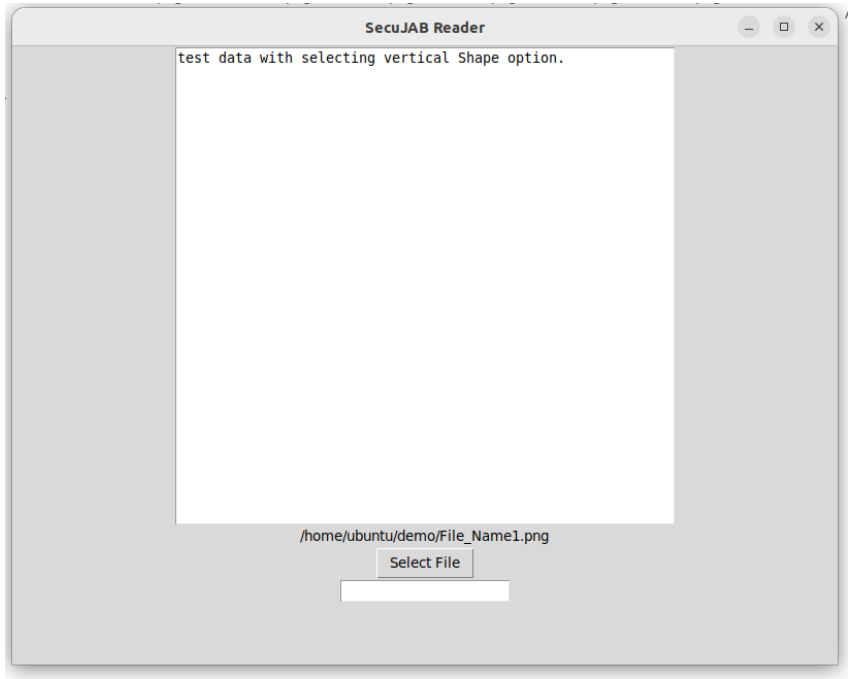
Fig26: Pili Kaner

Fig27: Putranjeeva

Fig28: Sinduri

Barcode Generation Vertical Shape





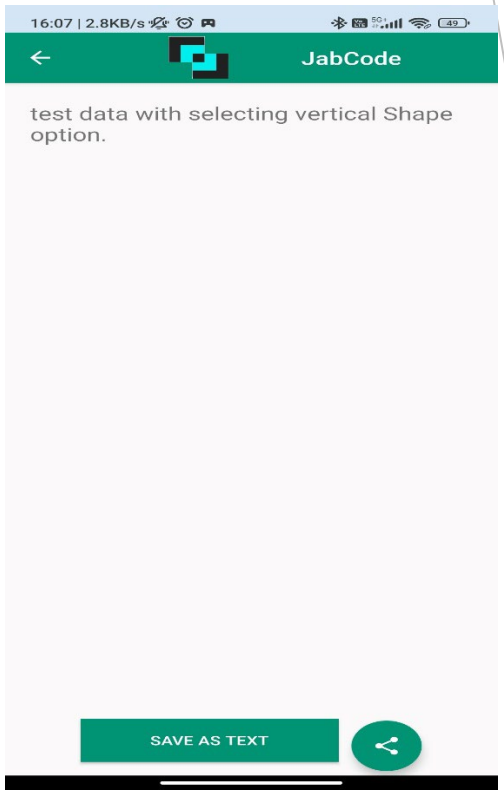
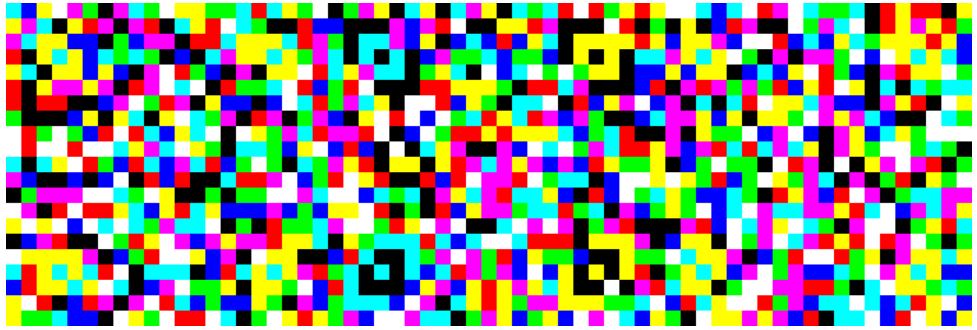


Fig. 29: Barcode generation using Vertical option and Outputs

Barcode Generation Horizontal Shape



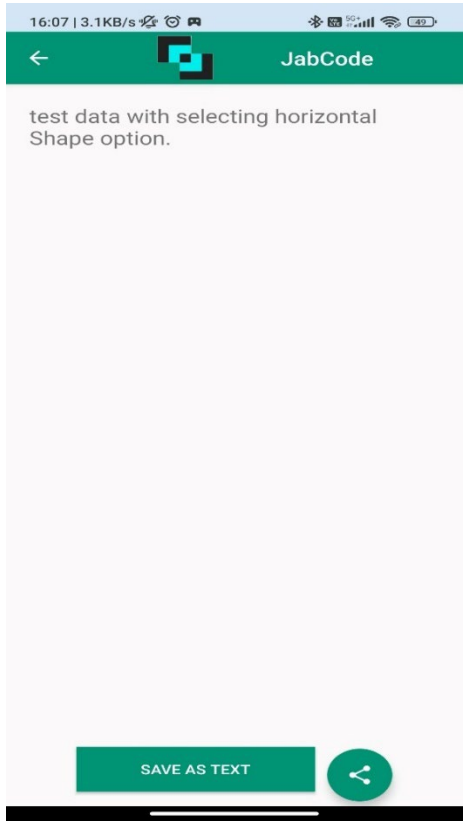


Fig. 30: Barcode generation using Horizontal option and Outputs

Barcode Generation U Shape

Fig. 31: Barcode generation using U Shape option

Output of barcode

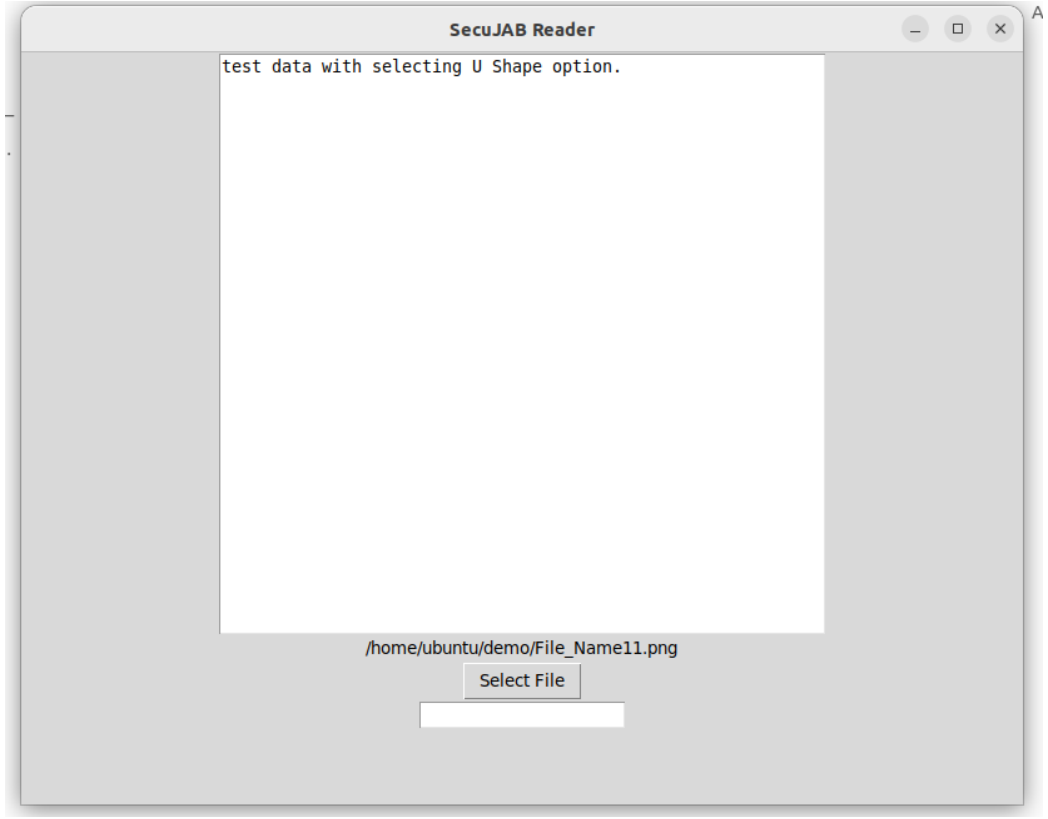
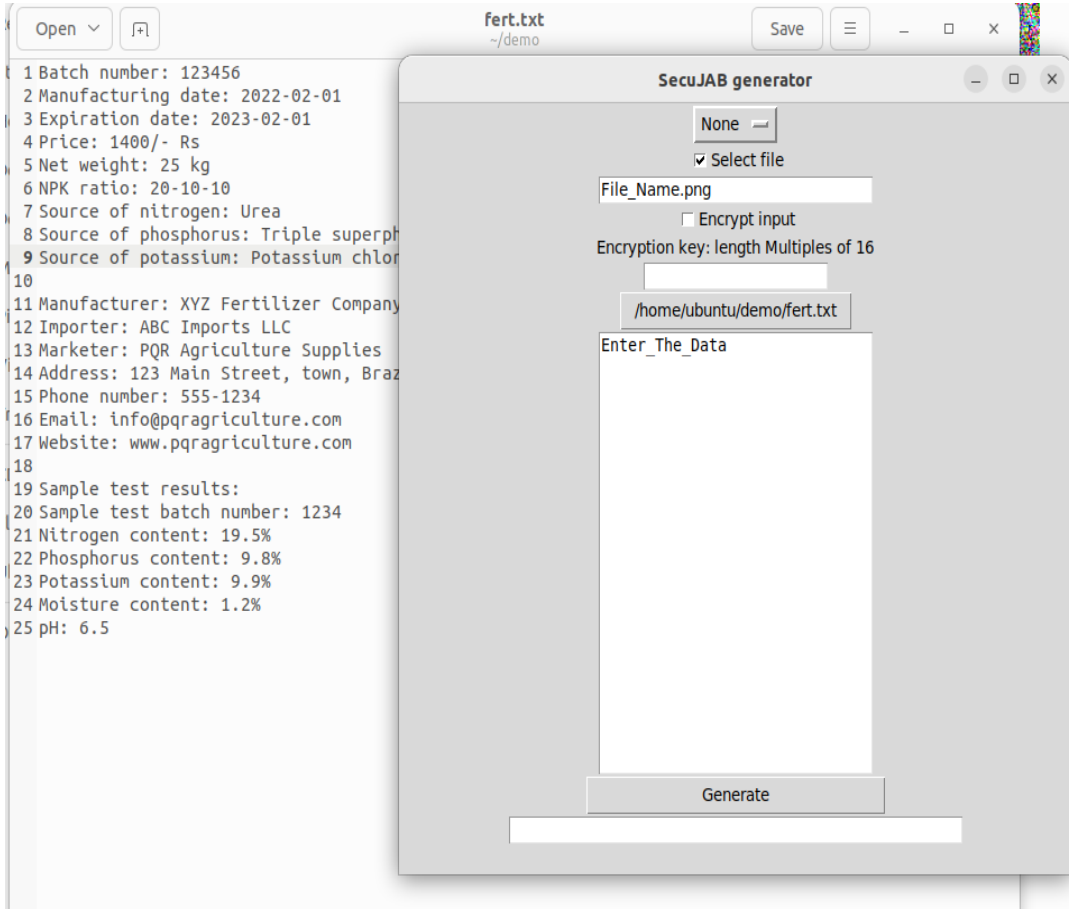
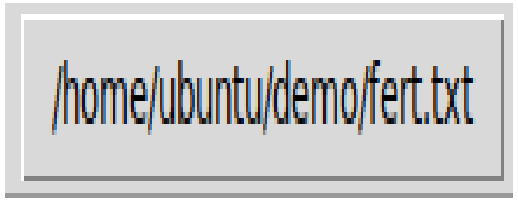


Fig. 32: Reading barcode with SecuJAB reader application

Fig. 33: Scanned barcode form mobile application

Barcode Generation using file





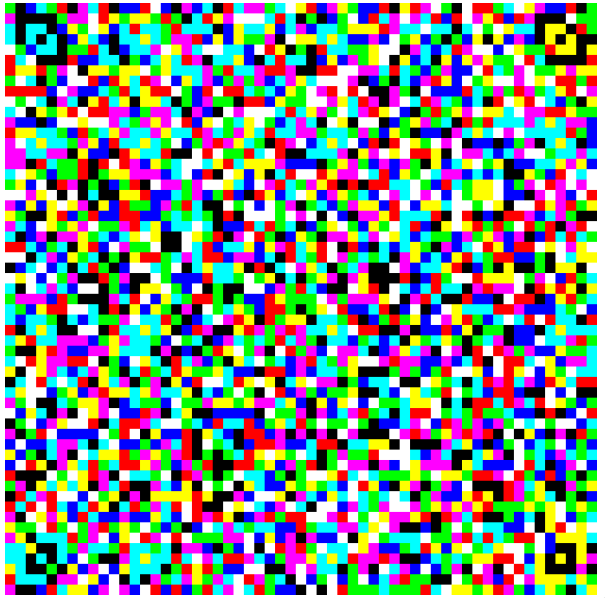


Fig. 34: Barcode generation using file option

Output

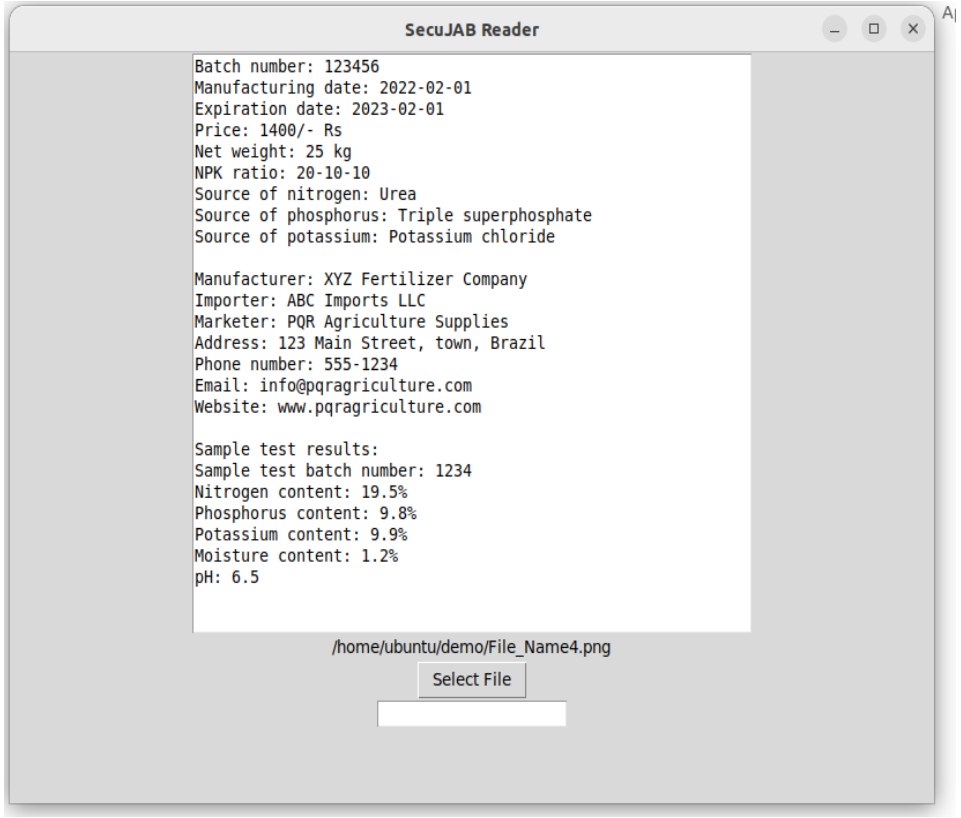


Fig. 35: Reading barcode with SecuJAB reader application

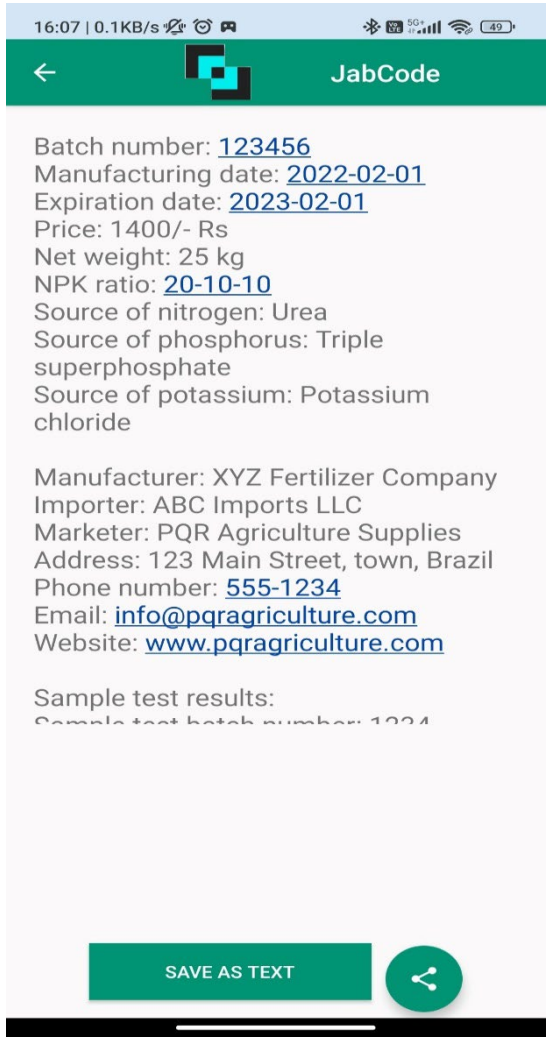
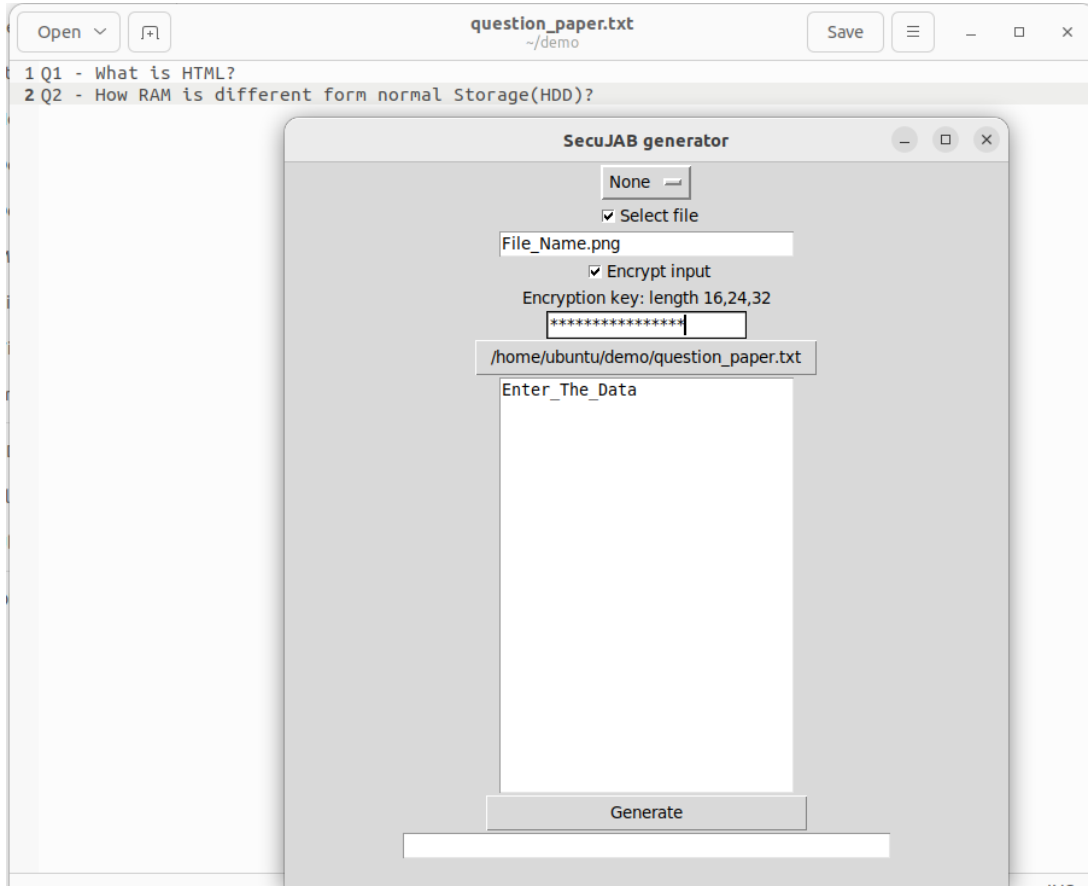
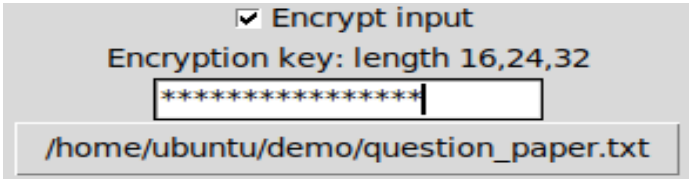


Fig. 36: Scanned barcode form mobile application

Barcode Generation using Encryption





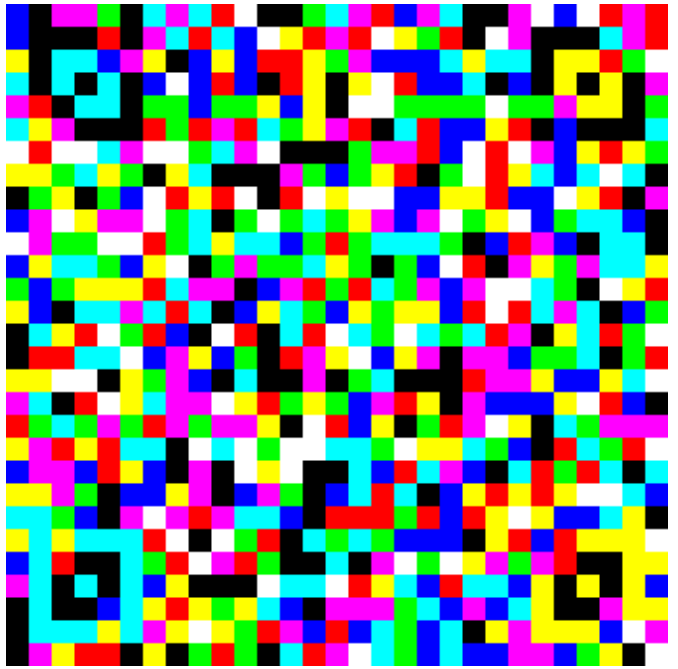


Fig. 37: Barcode Generation using Encryption

Output

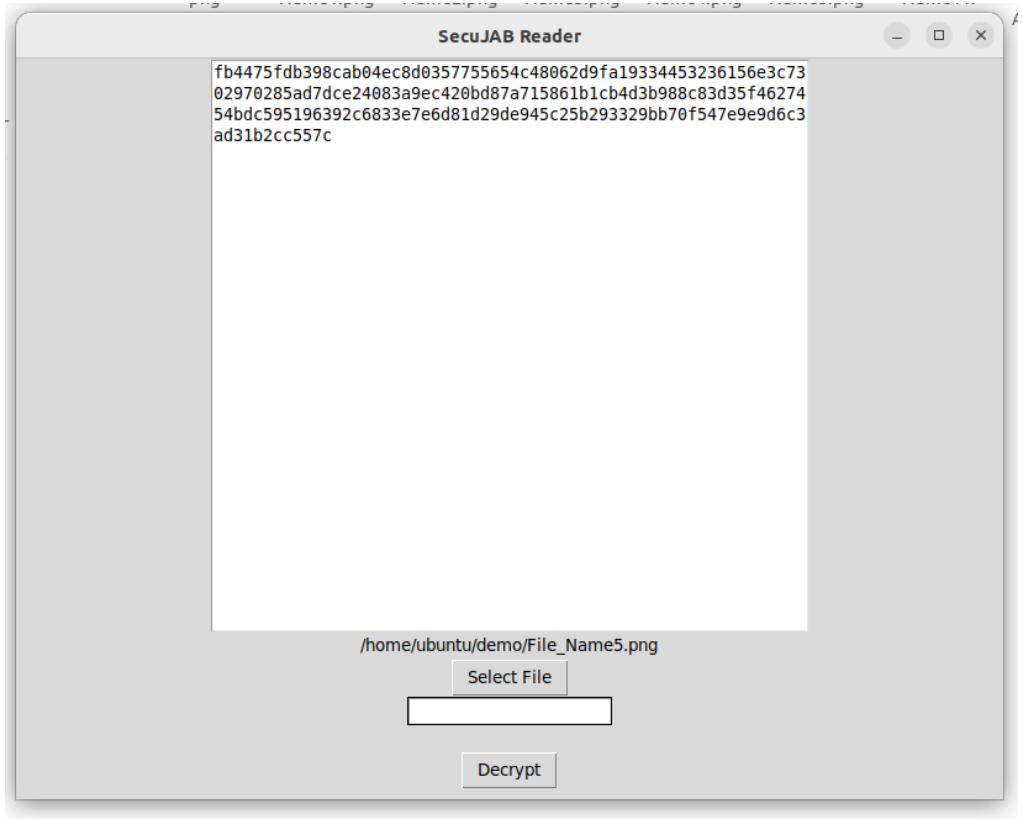
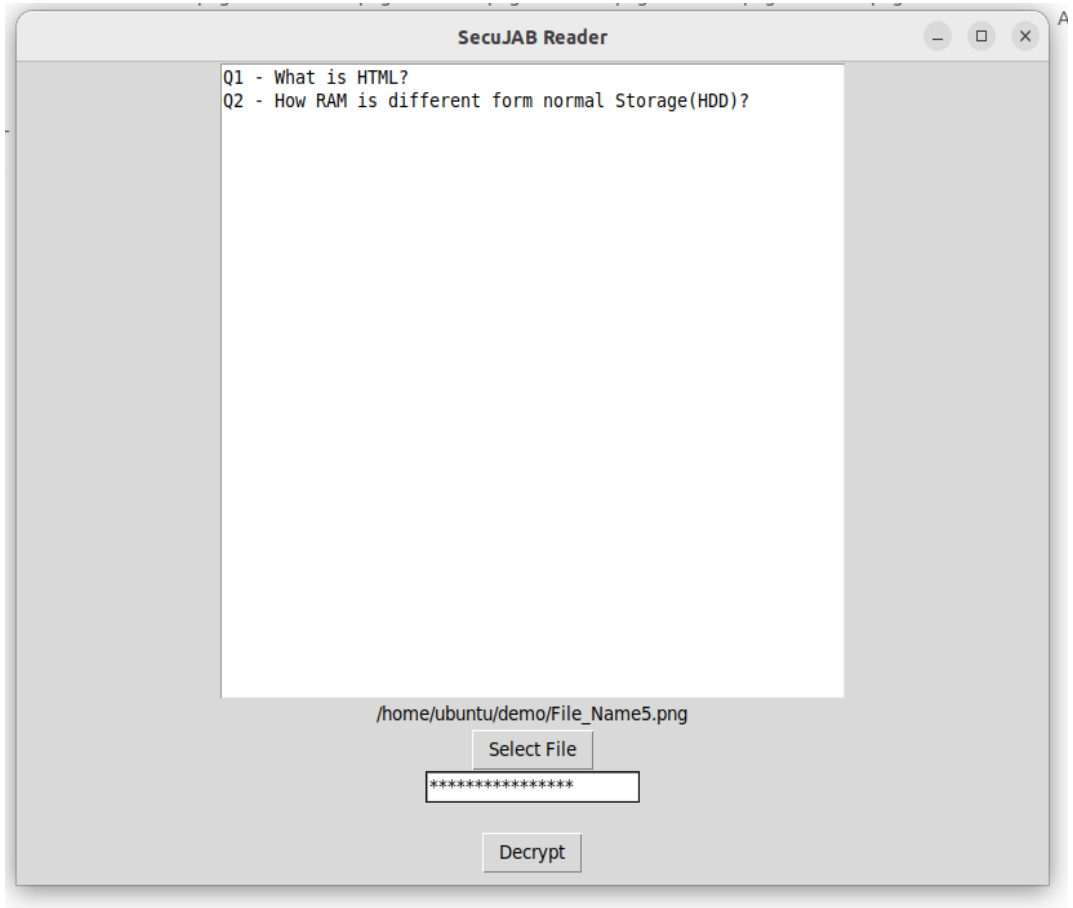


Fig. 38: Reading barcode with SecuJAB reader application

Fig. 39: Scanned barcode form mobile application

Output After Entering the Key



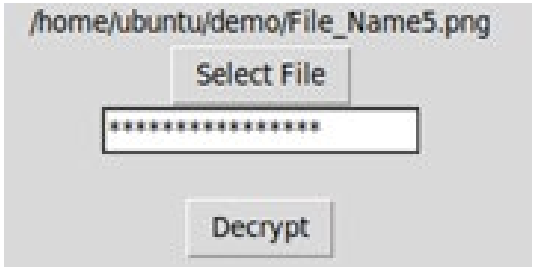


Fig. 40: Reading barcode with SecuJAB Reader application after Entering key

SUMMARY AND CONCLUSIONS

Summary

- A user-friendly desktop application has been developed using Python's tkinter library that allows users to interact with JAB Code encoding and decoding processes.
- JAB Code, a 2D colored matrix barcode presents higher data capacity and robustness against color distortion. This application aids in its adoption by simplifying user interaction.
- The application allows users to generate JAB Codes from their input or files, and choose the pattern in which the code is generated.
- One major feature is the integration of AES encryption, enhancing the security of the encoded information. Users can opt for encryption and input a key of their choice.
- The subprocess module is employed to interact with the system's command line, enabling usage of an existing JAB Code writer program in a simplified manner.
- This application promotes widespread adoption of JAB Code technology by offering a bridge between complex data encoding/decoding tech and non-technical users.

Conclusion

- The research successfully resulted in the creation of an application that simplifies the use of JAB Code technology, making it accessible to non-technical users.
- The addition of AES encryption in the process provides an extra layer of security to the encoded data.
- The application accommodates different user inputs (text and file input), and provides flexibility in JAB Code pattern selection.
- This represents a significant advancement towards increased adoption of JAB Code technology.
- The model developed can serve as a guide for rendering other advanced technologies more user-friendly and secure in the future.

REFERENCES

References

- **Berchtold, W., Liu, H., Steinebach, M., Klein, D., Senger, T. and Thenee, N. 2020.** JAB Code-A Versatile Polychrome 2D Barcode. *Electron. imag.*, 2020(3): 1-6.

- **Bulan, O., Monga, V. and Sharma, G. 2009.** High capacity color barcodes using dot orientation and color separability. '*In: Media forensics and security'* at San Jose, California, United States, during. January 18-22. pp. 397-403.

- **Dey, S., Agarwal, S. and Nath, A. 2013.** Confidential encrypted data hiding and retrieval using qr authentication system. '*In: International Conference on Communication Systems and Network Technologies (CSNT)'* at Gwalior, India, during. April 6-8. pp. 512-517.

- **Grillo, A., Lentini, A., Querini, M. and Italiano, G. F. 2010.** High capacity colored two dimensional codes. '*In: Proceedings of the international multiconference on computer science and information technology'* at Wisla, Poland, during. October 18-20. pp. 709-716.

References

- **Mittra, P. and Rakesh, N. 2016.** A desktop application of QR code for data security and authentication. '*In: International Conference on Inventive Computation Technologies (ICICT)'* at Coimbatore, India, during. August 26-27. pp. 1-5.

- **Parikh, D. and Jancke, G. 2008.** Localization and segmentation of a 2D high capacity color barcode. '*In: 2008 IEEE workshop on applications of computer vision'* at Copper Mountain, CO, USA, during. January 7-9. pp. 1-6.

- **Shao, F., Chang, Z. and Zhang, Y. 2010.** AES encryption algorithm based on the high performance computing of GPU. '*In: 2010 Second International Conference on Communication Software and Networks'* at Singapore, Singapore, during. February 26-28. pp. 588-590.

References

- **Winter, C., Berchtold, W. and Hollenbeck, J. N. 2019.** Securing physical documents with digital signatures. '*In: IEEE 21st International Workshop on Multimedia Signal Processing (MMSP)'* at Kuala Lumpur, Malaysia, during. September 27-29. pp. 1-6.

- **Yfantis, V., Kalagiakos, P., Kouloumperi, C. and Karampelas, P. 2012.** Quick response codes in E-learning. '*In: International Conference on Education and e-Learning Innovations'* at Sousse, Tunisia, during. July 1-3. pp. 1-5.

- https://github.com/jabcode/jabcode GitHub, jabcode/jabcode: jabcode - color bar code, 17/12/2022.

Thank You